REMARKS

Claims 1 to 17 are pending in the application.

Drawings

The drawing Fig. 2 submitted December 14, 2004, is objected to under 35 USC 132 as introducing new matter. The examiner states that the newly added material concerns showing the workpiece being supported on a single worktable. The examiner points out that the originally filed application does not support showing the workpiece mounted on a single worktable. The examiner further points out that it is not supported by the specification that a single workpiece could be supported on both tables. Applicant therefore submits a new drawing Fig. 2 showing only the workpiece and the two spindles working on it since this is the feature of the claims that must be illustrated; all extraneous material regarding the machine has been omitted.

The drawings are objected to under 37 CFR 1.83(a) for not showing the first and second spindles performing machining on a single workpiece. This is shown in newly submitted drawing Fig. 2.

Reconsideration and withdrawal of the objection to the drawings are therefore respectfully requested.

Information Disclosure Statement

Examiner states that the listing of references in the specification is not a proper Information Disclosure Statement and that it is required under 37 CFR 1.98(b) to list all patents, publications etc. on a separate paper. The examiner points out that the reference DE 19503482 was not listed on a separate sheet and is therefore not considered unless cited by the examiner on PTO-892.

It is respectfully submitted that in the Information Disclosure Statement dated 12/13/04 the undersigned has specifically stated that DE 19503483 is the equivalent of US 5,944,643 cited by the examiner. Where there is an English language equivalent of a foreign document, there is no need to submit the foreign document.

Claim Rejections - 35 U.S.C. 112

Claim 17 stands rejected under 35 U.S.C. 112, 2nd paragraph, as failing to comply with the written description requirement. The Examiner states that the claim sets forth the method including the steps of continuing workpiece machining by the second spindle

including accessing the second tool magazine during stocking of the first two magazine and continuing workpiece machining by the first spindle, including accessing the first tool magazine during stocking of the second tool magazine. In Examiner's opinion there is no support in the specification as originally filed. The term accessing has been changed to tool changing.

Applicant would like to point out that this is in effect disclosed in the specification in paragraph 0011 and 0018. In paragraph 0018 reference is being had to the chip-to-chip time and the main machining time. In cutting processes the chip-to-chip time or cut-to-cut time is defined as the time between beginning the removal of the tool to be exchanged from a working position and the completion of advancing the subsequent tool into the same machining position. This is a definition provided by the VDI Richtlinien 2852 (VDI = Verein deutscher Ingenieure = Association of German Engineers; Richtlinien = guidelines); see attached copy. The cover page VDI 2852 shows at the top left corner the English language terms of the subject matter of this section: "cut-to-cut time" (= chip-to-chip time) and "automatic tool change". On page 2, item 2 the definition of cut-to-cut time is provided. This text portion reads as follows (translation provided by the undersigned who is fluent in the German and English languages and states herewith that the following text is a true translation):

2. *Definition of the cut-to-cut time (CCT)*

The cut-to-cut time is defined as the time between beginning of removal of a tool to be exchanged from a representative machining position and the completion of advancing the subsequent tool of the same length into the same machining position.

The cut-to-cut time is better suited for evaluating automatic tool exchange processes than the pure tool change time because the CCT takes into consideration all required steps for performing the tool exchange within the context of an automated work process.

The CCT comprises

removal from the representative machining position to the tool exchange position
tool exchange process
advancing toward the representative machining position from the tool exchange position.

The cut-to-cut times t_1, t_2, t_3 represent statistical parameters for evaluating automatic tool exchange processes.

The item 3.4 of these guidelines defines the main machining time that is the tool engaging time t_h between the tool changes (effective machining time of a tool);

The instant specification discloses the terms "main machining time" as well as "chip-to-chip time" in connection with a tool changer. It is clear to a person skilled in the art that the main machining time refers to the time in which the tool actually machines the workpiece between the tool changes. The cited text portion mentions that the selection of the tools by the method according to the invention from the total magazines 2, 3 is carried out within the main machining time of the machine tool. This means that during the tool change that is taking place at the tool magazines 2 or 3, the workpiece is continuously machined by the spindle where no tool change is carried out. Accordingly, the method as claimed in claim 17 is properly disclosed. It should also be kept in mind that a tool changer (see attached copy of *McGraw-Hill Dictionary of Scientific and Technical Terms*) is known as a mechanism in program-controlled machines and robotics that allows the use of multiple tools for machining, i.e., machining means in the context of tool changers that various tools participate in various machining steps; the operation is described in paragraphs 0017 and 0018.

The method according to the invention is employed in the case of short tool machining times and frequent tool changes. When the tool machining step takes a long time, there is no problem in regard to stocking the tool machine during the long period of use of the tool. However, problems occur when the machining step of the tool is very short so that the machining step is already complete before the tool stocking process is carried out. It should also be noted that tool stocking and tool changing are two different things.

Tool changing occurs during the machining operation so that different machining steps with different tools can be performed in accordance with a sequence of machining steps provided by a machining program, i.e., the spindle accesses different tools provided in the tool magazine for carrying our different machining steps. Tool stocking refers to placing a set of tools into a tool magazine or replacing worn tools of a set of tools in a tool magazine and this is done by the machine operator from the exterior of the machine tool.

The problem of having short main machining times that are too short to allow the operator to replace or insert a new tool into the tool magazine is solved by the method according to the invention in that each spindle is provided with its own tool magazine and that during stocking of the first tool magazine 2 the workpiece machining (machining includes various machining steps being performed by different tools of the tool changer) by the second spindle 13 is continued and that during stocking of the second tool magazine 3 machining by means of the first spindle 12 is continued. Since the two spindles each access a separate tool magazine, the length of the machining step of the workpiece for each tool can be very short and frequent tool changes can be carried out by one spindle while the other spindle and its correlated tool magazine are being stocked with new tools.

Claims 1-17 stand rejected under 35 USC 112, second paragraph as being indefinite. The Examiner points out that in claims 1 and 9 the term "the device" has no antecedence. The claims have been corrected accordingly.

In regard to claim 17, the Examiner points out that the meaning of the above cited text portion in regard to "accessing" is unclear. The Examiner points out that in particular the wording "includes accessing" is unclear.

In view of examiners remarks, the term accessing has been changed to "tool changing".

Reconsideration and withdrawal of the rejection of the claims pursuant to 35 USC 112 are therefore respectfully requested.

Rejection under 35 U.S.C. 102

Claims 1-3 stand rejected under 35 U.S.C. 102(b) as being anticipated by *Soltermann et al. (US 5,971,904)*.

The method according to the present invention relates to tool magazines of a

machine tool that comprises at least a first spindle and a second spindle configured to be independently movable relative to one another at least in one axis. The first spindle has associated therewith a first tool magazine and the second spindle has associated therewith a second tool magazine. According to the method, workpiece machining and direct tool changing into and from the second tool magazine by the second spindle is continued during stocking of the first tool magazine; workpiece machining and direct tool changing into and from the first tool magazine by the first spindle is continued during stocking of the second tool magazine.

U.S. 5,971,904 does not disclose the method according to the invention. Firstly, the Examiner makes reference to Figs. 1 and 3. However, these two figures show different devices. Fig. 1 shows a prior art device (see col. 3, lines 36-37) and Fig. 3 shows a preferred embodiment of the patent. The two devices therefore have nothing in common but represent independent solutions.

Also, as disclosed in col. 2, lines 30-46, the device according to the cited reference is used to machine printed circuit boards etc. Such printed circuit boards are illustrated in Fig. 2 of the cited document. On a printed circuit board, always the same machining steps are performed, i.e., bores 17 are to be produced in the board 16. Because of such identical machining, a frequent tool change is not required. For this reason, there is no problem originating in the frequent tool changes for short main machining times. In col. 2, lines 47-51, the cited reference indicates that typically the tool can be used for 333 hours without changing. Accordingly, the machining times are long and exchange of tools is to be carried out only when the tool is worn.

The cited reference discloses a single tool magazine 21 comprised of main supports 30 for holding subsidiary supports (bars) 31 for at least two tools; see col. 4, lines 17-22. Stocking the tool magazine 21 with bars 31 is realized by means 41 and the bars 31 are removed from the main supports 30 by means 42. When individual bars 31 are moved to their respective transfer positions at the machining stations 7, the entire tool magazine is moving so that stocking of more bars 31 into the supports 30 of the tool magazine 21 is not possible at this time. Stocking of the tool magazine 21 with the tool carriers 31 is only possible when the tool magazine 21 stands still. Even through the machining device is provided with several spindles, there is only one mechanism of supplying tools to the

spindles: the circulating tool magazine 21 that is divided virtually by programming means 23 into sequential sub-assemblies having several bars 31. The bars 31 are designated to supply only a certain spindle with tools, but an independent operation of the bars is not possible because the tool magazine 21 as a whole must be stopped for inserting or removing the tool bars 31. It is not possible to stock a first "magazine" 31 for a first spindle with tools while the second "magazine" 31 is still available to supply a second spindle with tools so that machining at the second spindle, including tool exchange, can continue.

It would not be possible to perform the method according to the invention with the device of the prior art: as soon as a stocking process (removing old tools and providing new tools) is to be carried out, the chain of the tool magazine 21 into which the tool carriers 31 are inserted must be stopped. When the chain is stopped, a second spindle, during the stocking process of a first "magazine" 31, can no longer access tools in the second "magazine" 31 correlated with the second spindle because the single tool magazine 21 is stopped. Accessing tools in the second "magazine" 31 would be possible only if the chain of the tool magazine 21 could be moved. However, since the chain must be stopped during the stocking process, it would not be possible to carry out a tool exchange at the second spindle.

According to the present invention, the spindles 12, 13 each have their own tool magazine 2, 3, respectively. By providing individual tool magazines for each spindle, one tool magazine 2 or 3 can be stopped for stocking while the other tool magazine 3 or 2 can continue to supply tools for tool change to the other spindle in order to continue machining.

Therefore, the cited reference cannot anticipate or make obvious the present invention as claimed in claim 1.

Claims 1, 3 and 17 stand rejected under 35 U.S.C. 102(b) as being anticipated by *JP 6-304835*.

The examiner has provided a machine translation of the cited JP document. As stated at the top of the translation, the translation may not reflect the original contents precisely. For this reason, applicant has secured a proper and true translation (copy attached) from a translation service that correctly reflects the disclosure of the original document.

This document does not provide any disclosure that anticipates the method

according to the invention. The operation of the known device is disclosed in paragraphs 0026. According to this text portion, the two spindles 26, 28 operate simultaneously. In the paragraph 0032, it is described that there may be situations where an insufficient number of tools for machining the workpiece is present in the tool magazine 64. In such a situation, tools from the tool stocker 66 are transported into the tool magazine 64 by the tool delivery mechanism 68.

This does not anticipate the method according to the present invention. In the machine of this JP document the problem according to the invention does not occur because the tools are not directly stocked into the tool magazine 64. They are stocked in the tool stocker 66. The spindles are decoupled from the stocking operation of the tool stocker 66 by the transfer device 68. The spindles can therefore access the tool magazine 64 during stocking of the tool stocker 66 without any risk. There is no need for stopping operation of the spindles for stocking as the stocking process is independent of the tool magazine 64. Two different devices are used for stocking (66) and for tool change (64) so that the method of the present invention is not anticipated.

The present invention deals with tool change operations that must occur frequently because the tool engaging times are very short, for example, every ten seconds a tool must be changed in accordance with the machining program. In conventional devices, this time frame is insufficient for stocking without having to stop the spindle operation. When the tool machining step takes a long time before a tool change has to take place, stocking of the tool magazine can be performed of course during the main machining time without there being the need for stopping the spindle. However, when the tool machining step takes only a short period of time, it is not possible to stock the magazine without stopping the spindle and interrupting machining. Only with the method of the present invention where each spindle has its own tool magazine is it possible to stock the first magazine of the first spindle while the second spindle is still able to machine workpieces and perform tool exchange with the second tool magazine so that the productivity of the machine tool is maintained at 50 %.

Reconsideration and withdrawal of the rejection of the claims 1, 3, 17 pursuant to 35 USC 102 are therefore respectfully requested.

Rejection under 35 U.S.C. 103

Claims 1, 3 and 17 are alternatively rejected under 35 USC 103 and claims 2 and 4-16 stand rejected under 35 U.S.C. 103(a) as being unpatentable over *JP 6-304835.*

As pointed out above, the JP-document teaches that the two spindles 26, 28 are simultaneously in operation. A separate stocking of the tool magazines 64 while one of the spindles continues to operate is not disclosed. Stocking takes place independent of the tool magazines 64 at the tool stocker 66.

Reconsideration and withdrawal of the rejection of the claims 1-17 pursuant to 35 USC are therefore respectfully requested.

CONCLUSION

In view of the foregoing, it is submitted that this application is now in condition for allowance and such allowance is respectfully solicited.

Should the Examiner have any further objections or suggestions, the undersigned would appreciate a phone call or **e-mail** from the examiner to discuss appropriate amendments to place the application into condition for allowance.

Authorization is herewith given to charge any fees or any shortages in any fees required during prosecution of this application and not paid by other means to Patent and Trademark Office deposit account 50-1199.

Respectfully submitted on September 21, 2005,

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GEH
Encl.: - replacement drawing sheet Fig. 2 (1 sheet)
- copies of McGraw-Hill Dictionary (2 pages)
- VDI 2852 (4 pages)
- Translation of JP 6-304835 (6 pages)

DRAWING SHEET
10/065,021
Inventor: Artur Kurz
Filing Date: 9/11/2002

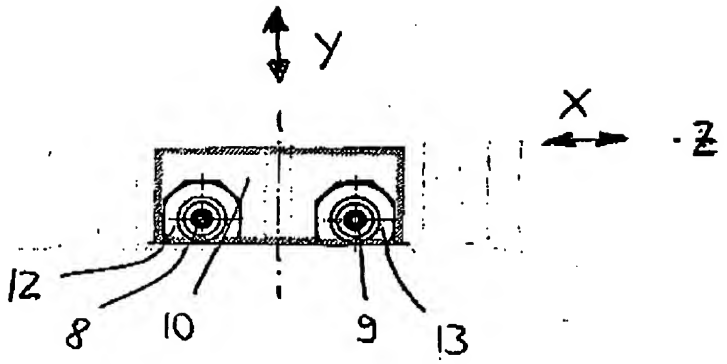


Fig. 2

McGRAW-HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS

Sixth Edition

McGraw-Hill

New York Chicago San Francisco
Lisbon London Madrid Mexico City
Milan New Delhi San Juan Seoul Singapore Sydney Toronto

one code ranging [NAV] In navigation by satellite, a method of transmitting a high-precision time signal using the reduced peak power available to a satellite; an audio frequency is used to phase an audio oscillator in the user equipment, and a train of short pulses is generated in synchronism with the zero crossings of the audio tone to provide high-resolution timing. { 'tōn ˌkōd ˌrānj·iŋ }

one control [ELECTR] A control used in an audio-frequency amplifier to change the frequency response so as to secure the most pleasing proportion of bass to treble; individual bass and treble controls are provided in some amplifiers. { 'tōn kənˌtrōl }

one dialing *See* push-button dialing. { 'tōn ˌdīl·iŋ }

one generator [ELECTR] A signal generator used to generate an audio-frequency signal suitable for signaling purposes or for testing audio-frequency equipment. { 'tōn ˌjen·əˌrād·ər }

one localizer *See* equisignal localizer. { 'tōn ˌlō·kəˌlīz·ər }

one-modulated waves [COMMUN] Waves obtained from continuous waves by amplitude-modulating them at audio frequency in a substantially periodic manner. { 'tōn ˌmäj·əˌlād·əd ˌwāvz }

one modulation [COMMUN] Type of code-signal transmission obtained by causing the radio-frequency carrier amplitude to vary at a fixed audio frequency. { 'tōn ˌmäj·əˌlā·shən }

one-only pager [COMMUN] A receiver in a radio paging system that alerts the user to call a specific telephone number. { 'tōn ˌōn·lē 'pāj·ər }

one-operated net-loss adjuster [COMMUN] System for stabilizing the net loss of a telephone circuit by a tone transmitted between conversations. { 'tōn ˌäp·ə,rād·əd 'net ˌlȯs ˌjəs·tər }

oner [GRAPHICS] The fine, black, resinous powder used in electrostatic imaging processes to make an electrostatic image visible; the toner is either deposited directly on coated paper or transferred from a charged surface to ordinary paper, then fused to the paper by heating. { 'tō·nər }

one-reversal [COMMUN] Distortion of the recorder copy in facsimile which causes the various shades of black and white dots to be in the proper order. { 'tōn riˌvər·səl }

ongara [METEOROL] A hazy, southeast wind in the Macassar Strait. { täŋ'gär·ə }

ong hold [MET] The end of a forging billet that is gripped by the operator's tongs; it is removed at the end of the forging operation. { 'täŋ ˌhōld }

ongrian [GEOL] A European stage of geologic time; lower Oligocene (above Lødian of Eocene, below Rupelian). Also known as Lattorfian. { 'täŋ·grē·ən }

ongs [DES ENG] Any of various devices for holding, handling, or lifting materials and consisting of two legs joined centrically by a pivot or spring. { təŋz }

ongue [ANAT] A muscular organ located on the floor of the mouth in humans and most vertebrates which may serve various functions, such as taking and swallowing food or tasting or as a tactile organ or sometimes a prehensile organ. [GEOL] 1. A rather rock-stratigraphic unit of limited geographic extent; it disappears laterally in one direction. 2. A lava flow branching off from a larger flow. [OCEANOGR] 1. A protrusion of water into a region of different temperature, or salinity, or dissolved oxygen concentrating. 2. A protrusion of one water mass into a region occupied by a different water mass. { təŋ }

ongue and groove [DES ENG] A joint in which a projecting tongue on the edge of one board fits into a groove in the edge of another board. { 'təŋ ən 'grüv }

ongue worm *See* acorn worm. { 'təŋ ˌwərm }

onic convulsion *See* tonic postural epilepsy; tonic spasm. { 'tän·ik kən'vəl·shən }

onic labyrinthine reflexes [PHYSIO] Rotation or deviation of the head causes extension of the limbs on the same side as the chin, and flexion of the opposite extremities: dorsiflexion of the head produces increased extensor tonus of the upper extremities and relaxation of the lower limbs, while ventroflexion of the head produces the reverse; seen in the young infant and in patients with a lesion at the midbrain level or above. { 'tän·ik ˌlab·ə'rin,thēn 'rēˌflek·səz }

onic neck reflexes [PHYSIO] Reflexes in which rotation or deviation of the head causes extension of the limbs on the same side as the chin, and flexion of the opposite extremities; dorsiflexion of the head produces increased extensor tonus of the upper extremities and relaxation of the lower limbs, and ventroflexion of the head, the reverse; seen normally in incomplete forms in the very young infant, and thereafter in patients with a lesion at the midbrain level or above. { 'tän·ik 'nek 'rēˌflek·səz }

tonic postural epilepsy [MED] A form of epilepsy in which seizures are characterized by a rigid posture with the arms and legs extended, hands pronated, and feet held in plantar flexion. Also known as tonic convulsion. { 'tän·ik 'päs·chə·rəl 'epˌlep·sē }

tonic spasm [MED] A spasm which persists for some time without relaxation. Also known as tonic convulsion. { 'tän·ik 'spaz·əm }

ton-kilometer [MIN ENG] A unit of measurement equal to the weight in tons of material transported in a mine multiplied by the number of kilometers driven. { 'tən 'kil·əˌmēd·ər }

ton-mile [CIV ENG] In railroading, a standard measure of traffic, based on the rate of carriage per mile of each passenger or ton of freight. { 'tən 'mīl }

tonnage [NAV ARCH] A measure of the size of a ship; it is usually taken to mean gross tonnage or net tonnage, but may also refer to deadweight or displacement tonnage. { 'tən·ij }

tonnage deck [NAV ARCH] In vessels having three or more decks to the hull, the tonnage deck is the second deck from the keel; in all other cases, it is the upper deck of the hull. { 'tən·ij ˌdek }

tonne [MECH] A unit of mass in the metric system, equal to 1000 kilograms or to approximately 2204.62 pound mass. Also known as metric ton; millier; ton; tonneau. { tən }

tonneau *See* tonne. { tə'nō }

tonofibril [CELL MOL] Any of the fibrils converging on desmosomes in epithelial cells. { ˌtō·nō'fī·brəl }

tonometer [MED] An electronic instrument that measures hydrostatic pressure within the eye; when placed in position, a tiny movable plate is pressed against the eye, flattening a circular section of the cornea (no eyeball anesthesia is required); a current is then sent through a small electromagnet, of such value that it will just pull the plate away from the eye; the value of the current is proportional to eye pressure; a measurement can be made in about 1 second; used in diagnosis of glaucoma. Also known as electronic tonometer. { tō'näm·əd·ər }

tonoplast [BOT] The membrane surrounding a plant-cell vacuole. { 'tō·nəˌplast }

tonsil [ANAT] 1. Localized aggregation of diffuse and nodular lymphoid tissue found in the throat where the nasal and oral cavities open into the pharynx. 2. *See* palatine tonsil. { 'tän·səl }

tonsillectomy [MED] Surgical removal of the palatine tonsil. { ˌtän·sə'lek·tə·mē }

tonsillitis [MED] Inflammation of the tonsils. { ˌtän·sə'līd·əs }

tonstein [GEOL] Kaolinitic bands in certain coalfields which have characteristic fossil fauna from short-lived but widespread marine invasions. { 'tänˌshtīn }

tonus [PHYSIO] The degree of muscular contraction when not undergoing shortening. Also known as muscle tone. { 'tō·nəs }

tool [ENG] Any device, instrument, or machine for the performance of an operation, for example, a hammer, saw, lathe, twist drill, drill press, grinder, planer, or screwdriver. [IND ENG] To equip a factory or industry for production by designing, making, and integrating machines, machine tools, and special dies, jigs, and instruments, so as to achieve manufacture and assembly of products on a volume basis at minimum cost. { tül }

toolbar [COMPUT SCI] A row or column of on-screen push buttons containing icons that represent frequently accessed commands. { 'tülˌbär }

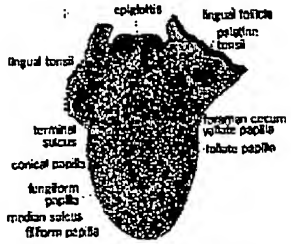
tool bit [ENG] A piece of high-strength metal, usually steel, ground to make single-point cutting tools for metal-cutting operations. { 'tül ˌbit }

toolbox [ENG] A box to hold tools. { 'tülˌbäks }

tool-center point [CONT SYS] The location on the end effector or tool of a robot manipulator whose position and orientation define the coordinates of the controlled object. { 'tül 'sen·tər ˌpȯint }

tool changer [MECH ENG] In program-controlled machines and robotics, a mechanism that allows the use of multiple tools. { 'tül ˌchānj·ər }

tool-check system [IND ENG] A system for temporary issue



The human tongue, dorsal view. (*From M. W. Woerdeman, Atlas of Human Anatomy, vol. 2, McGraw-Hill, 1950*)

TRANSLATION OF JP 6-304835

Übersetzung des Patents JP 6-304 835 durch Fa. Transline, Reutlingen

[Claim(s)]
[Claim 1] The tool exchanger for stock of the machine tool is placed on the mobile table which consists of the machine tool with two or more tools. It has a character to provide a tool magazine, a tool stocker and a tool delivery mechanism. A tool magazine performs automatic tool exchange work by the tool exchange mechanism between spindles of the above-mentioned machine tool. A tool stocker is installed outside the movement range of the above-mentioned machine tool and can store two or more tolls there. A tool delivery mechanism holds and delivers appointed tools between the above-mentioned magazine and the above-mentioned stocker with changing posture.
[Detailed Description of the Invention]

[0001] [Industrial Application]This invention concerns the tool exchanger for stock of the machine tool to exchange appointed tools between the tool magazine and the tool stocker. The tool magazine is moved with the machine tool as one, and the tool stocker stores two or more tools outside of movement range of the above-mentioned machine tool.

[0002] [Description of the Prior Art] Generally, the processing is performed for a work with a single spindle in NC (Numerical Control) machine tool. The problem that the efficiency of processing decreases is indicated when two or more processing are required for a work. Therefore, various improvements are examined to solve this kind of problem.

[0003] For example, a tool magazine which can store two or more tools is prepared, and the automatic tool exchanger to exchange appointed tools between the tool magazine and the spindles of the above-mentioned machine tool through the arm for exchange installed in the carriage which moves between the above-mentioned tool magazine and the machine tool is known. This is
unexamined in the JP, 04-66663.

[0004] [Problem(s) to be Solved by the Invention] However, in the prior art, the tool magazine is installed outside of movement range of the machine tool. Moreover, the arm for exchange installed in the carriage exchanges tools between the machine tool and the tool magazine by being rotated, moved back and forth and gyrated according to the carriage's moving between the above-mentioned machine tool and the tool magazine. Therefore, it takes considerable time for tool exchange work. Especially the problem, that the efficiency of the tool exchange work is not easily accomplished, is indicated when the exchange work is performed frequently.

[0005] This invention is for solving this kind of problem, and it aims to supply a tool exchanger for stock of the machine tool which realizes to exchange the desired tools for the spindle of the machine tool rapidly and easily, and also realizes to exchange two or more tools efficiently.

[0006] [Means for Solving the Problem] In order to attain the above-mentioned purposes, this invention is characterized in being placed on the mobile table on which it has two or more tools and composes a machine tool, and providing a tool magazine, a tool stocker and a tool delivery mechanism. A tool magazine performs automatic exchange work of tools by the tool exchange mechanism between spindles of the above-mentioned machine tool. A tool stocker is installed outside the movement range of the above-mentioned machine tool and can store two or more tolls there. A tool delivery mechanism holds and delivers appointed tools between the above-mentioned magazine and the above-mentioned stocker with changing posture.

[0007] [Function]In the tool exchanger for stock of the machine tool concerning this above-mentioned invention, a series of tools which are required for the appointed processing are stored in the tool magazine, which is placed on the mobile table that composes the machine tool, and the tool exchange work is rapidly accomplished by the tool exchange mechanism between this tool magazine and the spindle. Moreover, two or more tools which are stored in the tool stocker are installed in the spindle under an operation of the tool exchange mechanism after they are once delivered to the tool magazine by the tool delivery mechanism when many kinds of different processing are performed. Therefore, the desired tools for the spindle of machine tool can be installed rapidly and easily, and it makes possible to make the tool exchange work more efficiently when a processing work with many kinds and many processes more than the number of tools can be stored in the tool magazine is required.

[0008] [Example] It explains in detail about the tool exchanger for stock concerning this invention as follows. An example is given in relation to the machine tool incorporating this, and referring to the attached figure.

[0009] Reference mark 10 in the figure 1 to 3 shows the machine tool incorporating the tool exchanger for stock related to this example. This machine tool 10 provides the mobile table 14; the main body 16; and #1 "Going up

and down table" 20; #2 "Going up and down table" 24; and #1 and #2 "spindle unit" 26 and 28. The mobile table 14 can be moved back and forth to the direction of arrow X on the board 12 freely. The main body 16 of the machine tool which is supported on the mobile table 14 can be moved back and forth to the direction of arrow Z freely. The #1 "Going up and down table" 20 is installed in the front side of the main body 16 and can be moved up and down by #1 "servo-motor" 18. The #2 "Going up and down table" 24 is installed in the #1 "Going up and down table" 20 and can be moved up and down by #2 "servo-motor". And the #1 and the #2 spindle units 26 and 28 are attached to the above-mentioned #1 and #2 "Going up and down table" and vertically arranged.

[0010] The guide-rail 30a to 30c and the first drive-motor 43 are attached on the board 12. The ball screw 34 which is connected to the drive-motor 32 and extended to the direction of arrow X is connected with the nut material 36 placed in the mobile table 14. (Refer to the FIG. 3) The guide-rail 38 and 38 the second drive-motor are attached to this mobile table 14. And the ball screw 42 which is connected to this second drive-motor 40 and extended to the direction of arrow X is connected with the main body16. (Refer to the FIG. 2)

[0011] The ball screw 44 which extends toward the direction of vertical down connects to the first going up and down table 20. The ball screw 46 which extends toward the direction of vertical down from the second servo-motor 22 also connects to the second going up and down table 24. The first and second spindle units 26 and 28 provide the spindles 48 and 50, and these spindles 48 and 50 are connected with the same motor or a different motor respectively.

[0012] The tool exchanger 60 for stock concerning this operation is installed in the machine tool 10 which is composed like this. As shown in the FIG.1, this tool exchanger 60 for stock is placed on the mobile table 14 with two or more tools and provides the tool magazine 64, the tool stocker 66 and the delivery mechanism 68. The tool magazine 64 performs automatic exchange work of tool T between the spindles 48 and 50 for machine tool 10 through the tool exchange mechanism 62. The tool stocker 66 is installed outside of the movement range of the above-mentioned machine tool 10 and can store two or more tools freely. The tool delivery mechanism 68 holds the appointed above-mentioned tool T, changes posture and delivers the appointed above-mentioned tool T between above-mentioned tool magazine 64 and the above-mentioned tool stocker 66.

[0013] As shown in the FIG.3 and the FIG.4, the tool exchange mechanism 62 provides the drive unit 70, the gear case 72 supported by the drive unit 70, the casing material 74 supported by the gear case 72, and tool holding means 76 installed in the casing material 74. The drive unit 70 is installed on the side of main body 16. The gear case 72 supported by this drive unit 70 can be moved back and forth freely to the direction of an axis of the first and second spindle units 26, 28 (direction of arrow Z). The casing material 74 supported by the gear case 72 to be gyrated. The tool holding means 76 are installed on the both sides of radial direction (direction of arrow X), and can hold the first and second spindle units and two or more tools which are stored in the tool magazine 64.

[0014] The drive unit 70 provides the motor 78, and this motor 78 rotates the above-mentioned casing material 74. It also makes the gear case 72 and the casing material 74 moving back and forth. Moreover, this drive unit 70 provides a function to open and close the two chuck materials 80a, 80b, 82a, and 82b, which are attached to upper and lower sides and composes the tool holding means.

[0015] The tool magazine is polygon shaped (hexagon shaped), and is supported to the side of the mobile table 14 through the attachment material 84. It can be rotated freely through the motor 86 which is fixed to this attachment material 84, and every two or more sets of tool T are held outside of this attachment material 84 through the tool pot 88. These sets of tool T can be removed freely.

[0016] As shown in the FIG.1, the tool stocker 66 provides a pair of support 90 and 90, which is set to the back exterior (outside the movement range of the mobile table 14) of the board 12. And the frame 92 is fixed to the upper part of this support 90 and 90. The drive-motor 94 is installed in this frame 92, and the conveyor chain which has endless-state runs circulatory. Two or more tool pot 98 are attached to the conveyor chain 96 with predetermined interval, and many kinds of tool T are held in each tool pot 98 corresponding to the many processes.

[0017] As shown in the FIG.5, the tool delivery mechanism 68 provides the support 100 to be placed between the tool magazine 64 and the tool stocker 66 on the board 102. The rotation main body 102 is supported by this support 100. The drive cylinder 104 is attached to the support 100. The rack bar 106 is horizontally extended from this drive cylinder 104. This rack bar and the pinion 108 are fixed on the rotation main body 102 which engages with each other.

[0018] As shown in the FIG.6, the penetration holes: 110a and 110b are prepared in parallel and external rods 112a and 112b are rotated and inserted into these penetration holes 110a and 110b with different direction. Two or more circumferential gutters 114a and 114b are formed one by one with the appointed length on the outer side of the external rods 112a and 112b. These circumferential gutters 114a and 114b are engaged with the synchronized gear 116 as one.

[0019] The holes 118a and 118b are formed with the length from the one edge of the external rods 112a and 112b to the appointed length. The spline gutters 120a and 120b are prepared at the one edge.
The chuck parts 122a and 122b, which can be opened and closed freely are installed on the other edge of the external rods 112a and 112b.

[0020] The spline axis 124a and 124b are inserted into the holes 118a and 118b of the external rods 112a and 112b. These spline axis 124a and 124b are engaged with the spline gutters 120a and 120b. The chuck parts 126a and 126b are installed at the edge which stands out to the outside to be opened and closed freely.

[0021] The shift mechanism 128 is installed in the rotation main body 102 for the purpose to make the external rod 112a and 112b, and the spline axis 124a and 124b to move back and forth in the direction which separate them away from each other. This shift mechanism 128 provides the shift cylinder 130 to be fixed on the rotation main body 102, and the edge of the connecting plate 134 is connected with the rod 132 which is extended from this shift cylinder 130. This connecting plate 134 supports the edge of the external rod 112a and the edge of the spline axis 124b with free rotation through the bearing 136a and 136b.

[0022] The chuck part swinging mechanism 138 is installed at the edge of the spline axis 124a and the edge of the external rod 112b to swing the chuck parts 122a, 122b and chuck parts 126a, 126b as one. This chuck part swinging mechanism provides the gear case 142 to support the edge of spline axis 124a and the edge of the external rod 112b through the bearings 140a and 140b with free rotation. The drive-motor 144 is fixed to this gear case 142, and the drive-gear 148 is fixed to the rotation axis 146 of this drive-motor 144. This drive-gear 148 is engaged with the slave-gear 152, 154 through the gear train 150. These slave-gears 152 and 154 are fixed to the edges of spline axis 124a and the external rod 112b, and rotated to the different directions respectively.

[0023] As shown in the FIG.2, the main body 16a, which can be moved freely is placed on the board 12 individually through the mobile table 14a besides the above-mentioned main body 16. "a" is given to the same component as this main body 16 with the same reference number, and the detail description is omitted. The same tool exchanger for stock as the tool exchanger 60 for stock mentioned above (Not shown) is installed in the above-mentioned main body 16a side. The detail description is omitted.

[0024] The work-attach table (Not shown) is placed ahead of the main body 16 and 16a to position the work W (Refer to the FIG.3) and to maintain it.

[0025] Next, it explains the operation of the tool exchanger 60 for stock which is composed as shown in the FIG.3 in connection with the machine tool 10.

[0026] First of all, the work W is positioned on the work-attach table with the appointed processing posture and maintained. On the other hand, the appointed tool T and T are installed in the first and second spindle units 26 and 28 which are installed in the main body 16 in advance. Then, the tool T and T installed in the first and second spindle units 26 and 28 are rotationally driven as one, and each height location is adjusted corresponding to the processing part of work W under an operation of the first servo-motor 18 and the second servo-motor 22.

[0027] Then, the first and second spindle units 26 and 28 are positioned in the direction of arrow X to the work W when the first drive-motor is driven. Moreover, they are moved toward each processing part of the above-mentioned work W (direction of arrow Z forward) when the second drive-motor is driven.

[0028] Therefore, the rotating tool T and T which are installed in #1 and #2 spindle unit 26 and 28 accomplish the processing work automatically to the predetermined processing part of the work W by performing each operation which is mentioned above alternatively. #2 drive-motor 40 is driven to the opposite direction against the above-mentioned after processing work is completed, and the main body 16 detaches the tools T and T from the work-attach table by moving in the direction to detach from the work W. And the work W after processing is detached from the work-attach table, then a new work W before processing is attached to the work-attach table. The processing work for this new work W is accomplished by performing processing work which is mentioned above.

[0029] Next, when a processing work for the different kinds of work W is performed, the tool magazine 64 is rotated only the appointed angle under an operation of the motor 86 and it is stopped at the position that the desired tools T and T held at the outside part are placed toward horizontally. On the other hand, the first and second servo-motors 18 and 22 are driven, the first and second going up and down tables 20 and 24 are changed their positions vertically. The tools T and T which are installed in the first and second spindle units 26 and 28 are positioned corresponding to the height of the tool holding means 76 of casing material 74.

[0030] Then the motor 78 which composes the drive unit 78 is driven and the desired tools T and T maintained in the tool magazine 64 are held by the chuck materials 80a and 80b. On the other hand, the tools T and T installed in the spindles 50 and 48 are held by the chuck materials 82a and 82b. If the motor 78 rotates more, the casing material 74 is gyrated 180 degrees after the gear case 72 and the casing material 74 are moved forward.

[0031] Next, the tool T and T held in the chuck materials 80a and 80b are installed in the spindles 48 and 50 when the gear case 72 and the casing material 74 are retreated. The tools T and T held at the chuck materials 82a and 82b are also maintained in the tool pot 88 of the tool magazine 64. Then the chuck materials 80a, 80b and 82a, 82b are detached from tools T and T respectively, and moved toward inside of the casing material 74 then tool exchange work is completed.

[0032] By the way, it often happens that the number of tools T maintained in the tool magazine 64 is not much enough when processing for a work W which requires many processes using more than two tools T. For this reason, in this example, the tool stocker 66 which can store more than two tools T freely is placed toward outside of the board 12 and the work to exchange the appointed tools T between the tool magazine 64 and the above-mentioned tool stocker 66 is performed automatically through the tool delivery mechanism 68.

[0033] That is, the mobile table 14 is moved to the side of the board 12, and the tool magazine 64 is placed corresponding to the tool delivery mechanism 68. If the shift cylinder 130 which composes the shift mechanism 128 is driven and the rod 132 is extended toward outside here, the external rod 112a and spline axis 124b are moved toward outside (direction of arrow A, in the FIG.8) as one through the connecting plate 134 connected with this rod 132. The chuck parts 122a and 126b are positioned to the appointed tools T and T maintained in the tool pots 98 and 98 of the tool stocker 66.

[0034] In that case, if the external rod 112a is moved in the direction of arrow A, the synchronized gear 116 which is engaged with the circumferential gutter 114a formed on the outer side of the external rod 112a is rotated in the direction of arrow B in THE FIG.8. Moreover, the external rod 112b is moved to the opposite side against the direction of arrow A (direction of arrow C) through the circumferential gutter 114b which is engaged with this synchronized gear 116. The spline axis 124a is connected with this external rod 112b through the gear case 142, the above-mentioned spline axis 124a is moved in the direction of arrow C. Hereby, the chuck parts 122b and 126a are positioned to the appointed tools T and T maintained at the tool pots 88 and 88 of the tool magazine 64.

[0035] Next, the drive-motor 144 which consists of the chuck part swinging mechanism 138 is driven, and the rotating axis 146 and the drive gear 148 are rotated in one. The slave-gear 152 and 154 which is engaged with this drive gear 148 through the gear train 150 is rotated with the spline axis 124a and the external rod 112b in one. The external rod 112a and the spline axis 124b are also rotated with this spline axis 124a and the external rod 112b through the spline gutter 120a and 120b in one. For this reason, the chuck part 122a, 122b and the chuck part 126a, 126b are swung in one, the predetermined tool T and T which are maintained in the tool pot 98 and 98 of the tool stocker 66 and the predetermined tool T and T which are maintained in the tool pots 88 and 88 of the tool magazine are held. (Refer to the FIG.7)

[0036] Moreover, if the shift cylinder 130 is driven and the rod 132 is moved in the direction of arrow C, the external rods 112a, 112b and the spline axis 124a, 124b are moved in the direction in which both are adjacent (inside direction). Then the tools T and T which are held in the chuck parts 122a, 126b and the chuck parts 122b, 126a are picked out from the tool stocker 66 and the tool magazine 64.

[0037] Then, if the rack bar 106 is moved under an operation of the drive cylinder 104, the rotation main body is rotated just 180 degrees through the pinion 108 which is engaged with this rack bar 106. After that, the shift cylinder 130 is driven and the tools T which are held in the chuck parts 122a and 126b are maintained in the tool pot 88 of the tool magazine 64. The tools T which are held in the chuck parts 126a and 122b are also maintained in the tool pot 98 of the tool stocker 66. Moreover, the drive-motor 144 are rotated to the opposite direction against the above-mentioned direction, the chuck parts 122a, 122b, 126a and 126b are separated from the tools T away. And these chuck parts, 122a, 122b, 126a and 126b are moved back under an operation of the shift cylinder 130.

[0038] As described, the minimum number of tool T which are required for processing work of the predetermined work W are maintained in the tool magazine 64. And rapid exchange work for the desired tool T can be accomplished between this tool magazine 64 and the spindle 48, 50. The tool exchange work for tool T is accomplished automatically between the tool stocker 66 and the tool magazine 64 in which more than two tool T are stored through the tool delivery mechanism 68, when the processing for the work W which requires many processes using more than two tool T is performed. For this reason, many tool T are supplied to the tool magazine 64 sequentially. And this can realize to send many kinds of tool T to the spindle 48 and 50 through the tool exchange mechanism 62 rapidly. Hereby, it can be acquire an effect that an efficient tool exchange work is accomplished easily and automatically when the processing work for the work W which especially requires many processes using many kinds of tool T is performed.

[0039] [Effect of the Invention]According to the tool exchanger for stock of the machine tool concerning this invention, the following effects can be acquired.

[0040] A tool exchange work is performed automatically between the tool magazine prepared on the mobile table which composes a machine tool, and the tool stocker in which more than two tools are maintained placed outside of movement range of the above-mentioned machine tool through the tool delivery mechanism. Therefore, the desired tools can be rapidly and easily installed in the spindle of this machine tool by maintaining the desired tools in the tool magazine sequentially, especially when many kinds of work and many processes are required for a processing work. This makes possible to exchange desired tools efficiently and automatically for the spindles, even when more tools than the number of tools which can be stored in a tool magazine are used.

[Brief Description of the Drawings]
[FIG.1]It is a side-view explanatory drawing of the tool exchanger for stock concerning this invention.
[FIG.2]It is a front-view explanatory drawing of the machine tool incorporating above-mentioned tool exchanger.
[FIG.3]It is an important section top-view explanatory drawing of above-mentioned machine tool.
[FIG.4]It is a top-view drawing of the tool magazine, the tool stocker, the tool delivery mechanism and the tool exchange mechanism which compose the above-mentioned tool exchanger.
[FIG.5]It is a side-view drawing of the tool delivery mechanism which composes the above-mentioned tool exchanger.
[FIG.6]It is an important section drawing of longitudinal section of the above-mentioned tool delivery mechanism.
[FIG.7]It is a front-view explanatory drawing of the above-mentioned tool delivery mechanism
[FIG.8]It is a drawing of longitudinal section of the above-mentioned tool delivery mechanism to explain its operation.
[Description of Notations]
10 -- Machine Tool
12 12a - Board
14 14a – Mobile Table
16 16a – Main Body
18 22 - Servo-motor
26, 26a, 28, 28a -- Spindle Unit
48, 48a, 50, 50a – Spindle
60 60a -- Tool Exchanger
62 -- Tool Exchange Mechanism
64 -- Tool Magazine
66 -- Tool Stocker
68 -- Tool Delivery Mechanism
70 -- Drive Unit
72 -- Gear Case
74 -- Casing Material
76 -- Tool Holding Means
96 -- Conveyor Chain
98 -- Tool Pot
102 -- Rotation Main Body
104 -- Drive Cylinder
112a, 112b -- External Rod
116 -- Synchronized Gear
122a, 122b -- Chuck Part
124a, 124b – Spline Axis

126a, 126b – Chuck Part
128 – Shift Mechanism
130 – Shift Cylinder
138 – Chuck Part Swinging Mechanism
144 – Drive-motor

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VDI-RICHTLINIEN

Oktober 1984

VEREIN DEUTSCHER INGENIEURE

Kenngrößen numerisch gesteuerter Fertigungseinrichtungen

Span-zu-Span-Zeit bei automatischem Werkzeugwechsel

VDI 2852

Blatt 1

Cut-to-cut time, automatic tool change

Inhalt

VDI-Gesellschaft Produktionstechnik (ADB)
Fachbereich Produktionsanlagen
Ausschuß Einsatz numerisch gesteuerter Werkzeugmaschinen

1 Ziel der Richtlinie

Ziel dieser Richtlinie ist es, Kenngrößen des Nebenzeitverhaltens von NC-Anlagen eindeutig zu definieren, um vergleichende Betrachtungen ähnlicher Anlagen zu ermöglichen.

In dieser Richtlinienreihe werden im Blatt 1 die „Span-zu-Span-Zeit"
bei automatischem Werkzeugwechsel
und im Blatt 2 die
„Palettenwechsel-Zeit" und „Werkstückfolge-Zeit"
bei automatischem Werkstück-Palettenwechsel
beschrieben. Weitere Blätter werden ggf. folgen. Automatische Werkzeugwechsel-Einrichtungen sind vielfach Bestandteile von NC-Maschinen.

2 Definition der Span-zu-Span-Zeit (*SSZ*)

Die Span-zu-Span-Zeit wird definiert als Zeit zwischen dem Beginn des Wegführens eines auszuwechselnden Werkzeuges aus einer repräsentativen Bearbeitungsposition und dem Ende des Heranführens eines folgenden, gleich langen Werkzeuges in die gleiche Bearbeitungsposition.

Die Span-zu-Span-Zeit ist zur Beurteilung von automatischen Werkzeugwechselvorgängen besser geeignet als die reine Werkzeugwechselzeit, da die *SSZ* alle notwendigen Schritte zur Ausführung eines Werkzeugwechsels im Rahmen eines automatisierten Arbeitsablaufs berücksichtigt.

Die *SSZ* beinhaltet
Wegfahren von der repräsentativen Bearbeitungsposition zur Werkzeugwechselposition
Werkzeugwechselvorgang
Heranfahren zur repräsentativen Bearbeitungsposition von der Werkzeugwechselposition.

Die Span-zu-Span-Zeiten t_1, t_2, t_3 stellen statistische Kenngrößen zur Beurteilung von automatischen Werkzeugwechselvorgängen dar.

3 Randbedingungen zur Ermittlung der *SSZ*

3.1 Begriffsbestimmungen

A_s	Sicherheitsabstand zwischen P_B und der Ebene, in der der Werkzeugwechsel stattfindet
n	maximale Drehzahl bei rotierenden Werkzeugen
P_B	Repräsentative Bearbeitungsposition
P_w	repräsentative Werkzeugwechselposition (nur bei Stanz- und Nibbelmaschinen)
SSZ	Span-zu-Span-Zeit
t_h	Eingriffszeit (Hauptzeit)
WL	Werkzeuglänge (bei rotierenden Werkzeugen von Kegelbezugsebene bis Werkzeugspitze)
WL_r	repräsentative Werkzeuglänge
X_A	maximaler Arbeitsweg in X-Richtung
X_{PB}	Lage von P_B in X-Richtung
Y_A	maximaler Arbeitsweg in Y-Richtung
Y_{PB}	Lage von P_B in Y-Richtung
Y_{Pw}	Lage von P_w in Y-Richtung
Z_A	maximaler Arbeitsweg in Z-Richtung
Z_{PB}	Lage von P_B in Z-Richtung

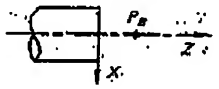
3.2 Repräsentative Bearbeitungsposition

Als repräsentative Bearbeitungsposition (P_B) wird ein Punkt im Arbeitsraum entsprechend den nachstehenden Skizzen für die einzelnen Maschinenarten festgelegt.

3.2.1 Repräsentative Bearbeitungsposition (P_B) bei Drehmaschinen

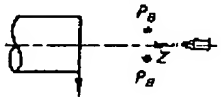
Alle Positionen (P_B) beziehen sich auf Werkzeuglänge $WL = 0$

3.2.1.1 Futter-/Längsdrehmaschine
(Drehlänge bis 3000 mm)



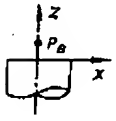
$X_{PB} = 0$
$Z_{PB} = 0{,}25 \cdot Z_A$

3.2.1.2 Längsdrehmaschine
(Drehlänge über 3000 mm)



$X_{PB} = \pm 0{,}2 \cdot X_A$
(+ bei Drehen vor Drehmitte)
(– bei Drehen hinter Drehmitte)
$Z_{PB} = 0{,}25 \cdot Z_A$

3.2.1.3 Vertikal-Drehmaschine



$X_{PB} = 0$
$Z_{PB} = 0{,}25 \cdot Z_A$

3.2.2 Repräsentative Bearbeitungsposition P_B bei Bohr-Fräsmaschinen

Alle Positionen P_B beziehen sich auf die Werkzeugspitze.

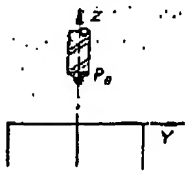
Die repräsentative Werkzeuglänge WL_r beträgt in Abhängigkeit von der Werkzeugaufnahme:

$WL = 160 \pm 1$ mm bei Steilkegel Nr. 30
$WL = (175) \pm 1$ mm bei Steilkegel (Nr. 35)
$WL = 190 \pm 1$ mm bei Steilkegel Nr. 40
$WL = 220 \pm 1$ mm bei Steilkegel Nr. 45
$WL = 260 \pm 1$ mm bei Steilkegel Nr. 50
$WL = 300 \pm 1$ mm bei Steilkegel Nr. 60

Spezial-Werkzeugaufnahmen (Sonderadapter, Zylinderaufnahme) sind analog zu den Steilkegelgrößen einzustufen.

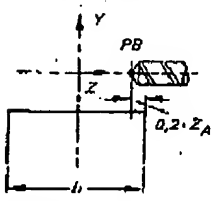
Die Werkzeug-Korrekturspeicher sind auf den Wert „Null" zu stellen.

3.2.2.1 Vertikal-Bohr- Fräsmaschine
Portal-Bohr-Fräsmaschine



X_{PB} = (Tischmitte)
Y_{PB} = (Tischmitte)
$Z_{PB} = 0{,}25 \cdot Z_A$
(ab Tischoberfläche)

3.2.2.2 Horizontal-Bohr-Fräsmaschine

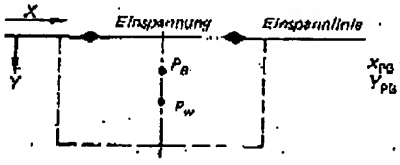


X_{PB} = (Tischmitte)
$Y_{PB} = 0{,}25 \cdot Y_A$
(ab Tischoberfläche)
$Z_{PB} = 0{,}2 \cdot Z_A$
(ab Vorderkante des Maschinentisches bzw. des Plattenfeldes in Richtung Tischmitte)

Bei rechteckigen Tischen ist b die kürzere Abmessung.

3.2.3 Repräsentative Bearbeitungsposition P_B bei Stanz- und Nibbelmaschinen

Die Mittelachse des Bearbeitungswerkzeugs befindet sich in der repräsentativen Bearbeitungsposition P_B.



X_{PB} = beliebig
$Y_{PB} = 0{,}25 \cdot Y_A$
(ab Einspannlinie des Werkzeugs)

3.3 Werkzeugwechselposition

Das Werkzeug wird in der konstruktiv festgelegten Werkzeugwechselposition gewechselt.

Ist diese im Bearbeitungsraum beliebig wählbar, so ist um den kürzestmöglichen Weg zurückzufahren, um kollisionsfrei wechseln zu können. Die Sicherheitsabstände sind hierbei einzuhalten:

Bei Drehmaschinen muß ein Mindest-Sicherheitsabstand $A_s = 5$ mm zur repräsentativen Bearbeitungsposition eingehalten werden.

Bei Bohr-Fräsmaschinen wird das Werkzeug zunächst in Richtung Z (und ggf. gleichzeitig in X, Y oder W) vom Werkstück weggefahren. Die Mindestlänge des Verfahrwegs richtet sich – soweit erforderlich – nach dem Weg für das Herausziehen des Werkzeugs aus der Arbeitsspindel.

Der Mindest-Sicherheitsabstand A_s zur repräsentativen Bearbeitungsposition P_B von 50 mm darf beim Werkzeugwechselvorgang nicht unterschritten werden.

Bei Stanz- und Nibbelmaschinen muß – sofern nicht in der repräsentativen Bearbeitungsposition gewechselt werden kann – die repräsentative Werkzeugwechselposition P_W auf $Y_{PW} = 0{,}5 \cdot Y_A$ gelegt werden.

3.4 Eingriffszeit (Hauptzeit)

Die zwischen den Werkzeugwechseln liegende Werkzeug-Eingriffszeit t_h muß zehn Sekunden betragen. Während dieser Zeit müssen rotierende Werkzeuge mit festgelegter Drehzahl drehen.

3.5 Werkzeugdrehzahl

Rotierende Werkzeuge müssen zu Beginn und Ende des Werkzeugwechsels mit einer Drehzahl von

$n = 1800 \text{ min}^{-1}$

drehen.

3.6 Span-zu-Span-Zeiten

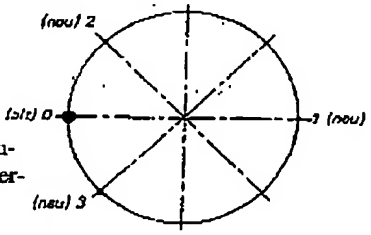
Um die Span-zu-Span-Zeiten zu ermitteln, sind die drei Zeiten t_1, t_2, t_3 zu messen.

t_1 Span-zu-Span-Zeit für das im Werkzeugmagazin auf dem zum ersten auszuwechselnden Werkzeug am entferntesten Platz stehende Werkzeug (Punkt 1)

t_2 Span-zu-Span-Zeit für das auf dem rechten Nachbarplatz zum ersten auszuwechselnden Werkzeug stehende Werkzeug (Punkt 2)

t_3 Span-zu-Span-Zeit für das auf dem linken Nachbarplatz zum ersten auszuwechselnden Werkzeug stehende Werkzeug (Punkt 3)

Beispiel:
Tellermagazin
Analog ist bei Kettenmagazin und Revolverköpfen zu verfahren



Die Messungen für t_1, t_2, t_3 sind gemäß Abschnitt 4.2 durchzuführen.

4 Meß- und Auswerteschema

Maschine .....

Fabrikat .....

Typ .....

Anzahl Werkzeuge im Magazin .....

Werkzeug-Aufnahme (-Kegel) .....

4.1 Vorbereitete Werte

4.1.1 Repräsentative Bearbeitungsposition P_B

Maschinen-Arbeitsraum (maximale Verfahrwege)	→	Repräsentative Bearbeitungsposition P_B
X_A = ... mm		X_{PB} = ... mm
Y_A = ... mm		Y_{PB} = ... mm
Z_A = ... mm		Z_{PB} = ... mm

Werkzeuglänge WL = ... mm

Die Werkzeug-Korrekturspeicher müssen auf „Null" stehen, da sonst die Zeitmessung durch den Korrekturspeicherwert beeinflußt wird.

4.1.2 Werkzeugwechselposition

a) liegt konstruktiv fest
oder

b) X_{Pw} = ... mm

Y_{Pw} = ... mm

Z_{Pw} = ... mm

Sicherheitsabstand A_s = ... mm

4.1.3 Eingriffszeit (Hauptzeit) zwischen den Werkzeugwechseln

$t_h = 10\ s$

4.1.4 Drehzahl des rotierenden Werkzeugs

$n = 1800\ min^{-1}$

4.2 Messungen

Das Werkzeug ist eingewechselt und steht in der repräsentativen Bearbeitungsposition.

Bei rotierendem Werkzeug ist vom Programm oder von Hand die festgelegte Drehzahl eingeschaltet.

Das Werkzeug wird zehn Sekunden lang über programmierte Verweilzeit oder über einen sehr kleinen Vorschub in der Bearbeitungsposition gehalten.

Anschließend erfolgt der Werkzeugwechsel.

Hierbei wird zur Ermittlung der Zeiten t_1, t_2, t_3 jeweils dreimal hintereinander ein Werkzeugwechselvorgang mit dazwischen liegender Eingriffszeit t_h = 10 sec ausgeführt.

Die Gesamtzeit ist um die drei Eingriffszeiten von insgesamt 30 sec zu reduzieren und durch drei (Anzahl der Messungen) zu dividieren.

z. B.

$$t_1 = \frac{t_{1\,(ges)} - 30}{3} \text{ in s}$$

5 Ergebnis

Span-zu-Span-Zeit

$t_1(\ ) =$ ..... [s]

$t_2 =$ ..... [s]

$t_3 =$ ..... [s]

Bei t_1 ist die Anzahl der Magazinplätze, die im direkten Zugriff des Wechselsystems liegen, als Index anzugeben (gemäß Angaben unter Abschnitt 4) z. B.

$t_{1\,(24)} = t_1$ bei Magazinkapazität von 24 Werkzeugen

Ein Bezug auf Richtlinie VDI 2852 Bl. 1 ist nur zulässig, wenn alle drei Zeiten (t_1, t_2, t_3) angegeben werden. Die Einzelangabe ist auch dann erforderlich, wenn $t_1 = t_2 = t_3$ ist.